

2007 Town Meetings for NSAC Long Range Plan, January 19-21, Chicago



*Report
of
**Nuclear Astrophysics / Study
of Nuclei Town Meeting**
for
2007 NSAC Long Range Plan*

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NSD Staff Meeting, Monday, February 5, 2007

Important points to address

- Identify the most compelling scientific questions and opportunities for the next decade (within US) and their scientific impact.
- What facilities and other resources are needed for realizing these opportunities?
- A "lower cost" version of an advanced Rare Isotope facility is explicitly mentioned in the charge as the main major new facility for our area compatible with projected funding levels. What role does this facility play in realizing the major future opportunities in the area you are covering?
- What other needs does your field have until this new facility is operational?
- What will be the scientific impact on other fields, are there interdisciplinary aspects?
- Identify the major accomplishments in your area since the last long range plan.
- What has been the impact of this progress within and outside of the field?

Town meeting structure

- Joint Plenary Sessions - with the town meeting on Neutrinos, Neutrons, Fundamental Symmetries
- Plenary Sessions
- Parallel Working Group Sessions (10)
- Summary Session
 - Four draft recommendations

Joint Plenary Sessions with the town meeting on Neutrinos, Neutrons, Fundamental Symmetries

- Charge and LRP process (R. Tribble)
- Report from the workshop on education (P. McMahan-Norris)
- Nuclear Structure (R. Casten)
- Neutrino Physics (S. Freedman)
- Nuclear Astrophysics (J. Truran)
- Fundamental Symmetries (M. Ramsey-Musolf)
- NSAC Report on Theory (B. Mueller)
- Status Report NSAC RIB Task Force (J. Symons)
- Deep Underground Science and Engineering Laboratory (DUSEL) (J. Kotcher)
- Institute for Nuclear Theory (D. Kaplan)

Plenary Sessions

- Stellar Nuclear Astrophysics (M. Wiescher)
- Nuclear Structure I (A. Macchiavelli)
- Theoretical Challenges in the Physics of Nuclei (W. Nazarewicz)
- Nuclear Structure Research at Jefferson Lab (K. de Jager)
- Nuclear Structure II (Th. Glasmacher)
- Nuclear Matter EOS in the Laboratory and in Astrophysics (J. Lattimer)
- Nuclear physics of exploding stars (J. Blackmon)

Parallel Working Group Sessions and Conveners (I)

- **Nuclear structure and reactions** (L. Cardman, R. Grzywacz, M. Carpenter, A. Gade, F. Liang) 47 talks
- **Nuclear Theory** (T. Duguet, E. Ormand, R. Wiringa) 26
- **Experiments with hot nuclei, dense matter** (W. Lynch, S. Yennello, L. Sobotka) 11 talks
- **Nuclear Astrophysics** (A. Champagne, G. Fuller, M. Wiesche) 11talks

Parallel Working Group Sessions and Conveners (II)

- **Joint nuclear physics** (L. Cardman, R. Grzywacz, E. Ormand, R. Wiringa, S. Yennello) 5 talks
- **Nuclear Astrophysics** (A. Champagne, G. Fuller, M. Wiescher) 12 talks
- **Nuclear Structure and Astrophysics** (Theory and Experiment) (A. Aprahamian, D. Dean) 14 talks
- **Nuclear Matter EOS in the Lab and in Astrophysics** (J. Piekarewicz, S. Reddy, B. Tsang) 9 talks
- **Applications and Nuclear Data** (A. Hayes, E. Norman, M. Chadwick)
- **Facilities and Instrumentation** (J. Beene, J. Nolen, I.Y. Lee, M. Thoennessen) 19 talks

Science drivers

- Properties of asymmetric nuclear matter.
- Nuclear structure and reactions critical to star evolution.
- Production and properties of heavy nuclei.
- Evolution of nuclear properties toward neutron drip line.
- To arrive at a comprehensive and unified microscopic description of all nuclei and low-energy reactions.

Draft Resolution #1

- The highest priority for major new construction in nuclear physics be the construction of a heavy-ion linac based rare isotope facility, including the capabilities for stopped, re-accelerated and in-flight beams.

NSAC RIB Task Force Background

(J. Symons)

- In 2001, our field gave RIA highest priority for new construction.
- In 2003, the DOE Office of Science gave RIA very high ranking in its 20 Year Vision.
- In 2006, Congress asked DOE a number of questions about their intentions with regard to RIA and received a detailed response:
 - Not going to build it, but
 - Liked the general idea
 - Would like to build something at about half the cost, starting at the end of the decade
 - Would keep R&D going, but not for RIA

NSAC RIB Task Force Charge

(J. Symons)

The results of this study should determine whether a forefront facility that will produce outstanding science in an international context within the suggested funding envelope can be defined, and if so, should identify the best option(s) for this facility. The report should contain sufficient details of the scientific capabilities and reach of the facility to inform the scientific community and NSAC in their development of the Long Range Plan, and sufficient technical detail so as to provide the guidelines to define such a facility in a request for proposals.

NSAC RIB Task Force Plan

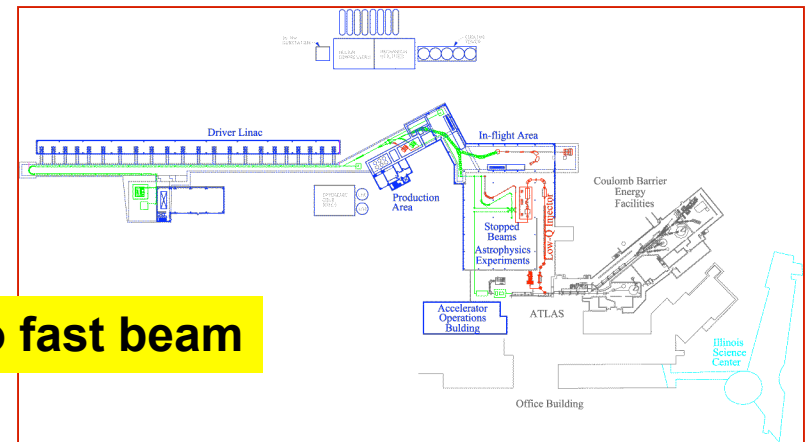
(J. Symons)

- Study carefully the recommendations of this town meeting
- Attempt to quantify the scientific reach of the various options
- Discuss the international context
- Develop our recommendations
- Write a report
- Submit it to NSAC in March

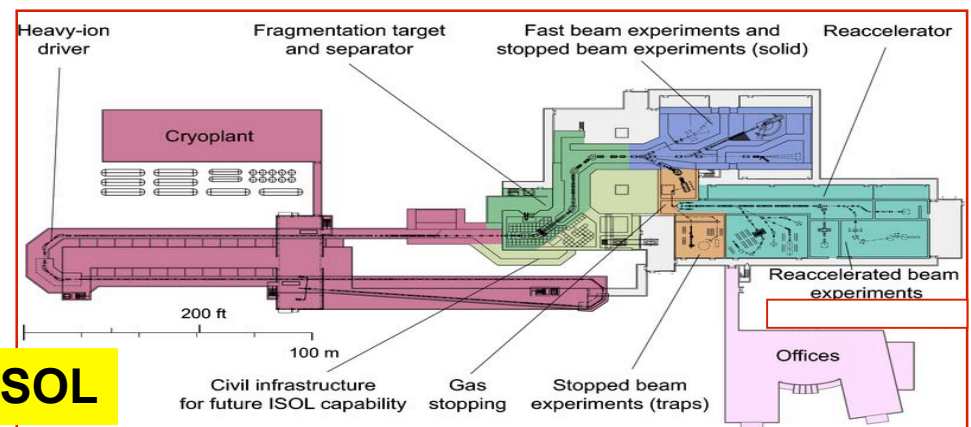
FRIB (a.k.a. RIA)

Two plans presented with lively discussions

- Cost ~\$500M
- Driver beam:
200MeV/A U, 400kW
- Capability for
 - Stopped beams
 - Gas stopping and reacceleration to 12MeV/A
 - In-flight beams



ANL AEBL



MSU ISF

What is lost compared with the \$1.1B facility

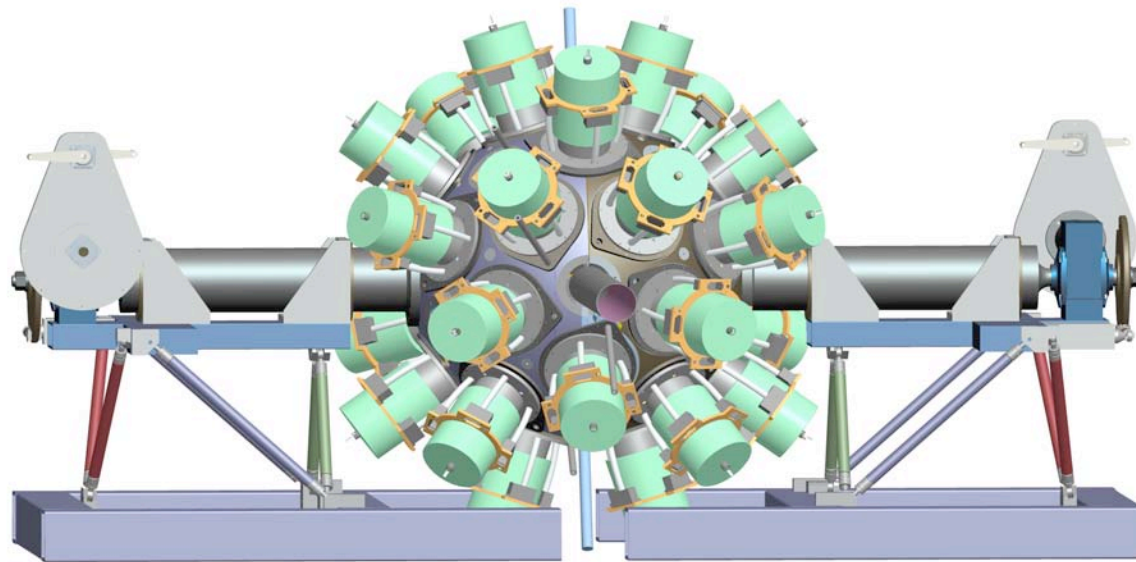
- Lower driver energy (same beam power)
 - 400MeV/A → 200MeV/A
- No multi-user capabilities
 - Single beam
- Reduced space for experiments
- No budget for new instrumentation (Use existing instrumentation and continue detector development and construction)

Draft Resolution #2

- Appropriate funds for operations and near-term upgrades of existing rare isotope research capabilities at ANL, NSCL, ORNL, and other national and university laboratories be supported. In particular, it is critical that funding be increased immediately to allow the effective utilization of the US national user facilities.

Draft Resolution #3

- Construction of the GRETA array begin immediately upon the successful completion of the GRETINA array.



From GRETINA to GRETA

- GRETINA ($\frac{1}{4}$ of full solid angle) is under construction and will be completed in 2010
- GRETA (4π) will improve the power of GRETINA by Factors of 10 – 100.
- GRETA is the most requested instrument at the next generation radioactive beam facility
- Complete GRETA in 2016
 - Critical path determined by detector production.
 - No gap between GRETINA and GRETA
 - Physics program to start 2008 with continue growth of capabilities.
 - Match FRIB schedule, ready when FRIB starts 2017
 - Competing European project AGATA plan to be completed in 2016

Draft Resolution #4

- Strongly increase support for theoretical efforts in the areas of nuclear structure, nuclear reactions, and nuclear astrophysics, in concert with an overall increase in nuclear theory as recommended in the 2003 NSAC Theory subcommittee report.

Theory of Nuclei

(Witold Nazarewicz)

Overarching goal:

To arrive at a comprehensive and unified microscopic description of all nuclei and low-energy reactions from the the basic interactions between the constituent protons and neutrons

- Self-bound, two-component quantum many-fermion system
- Complicated interaction based on QCD with at least two- and three-nucleon components
- We seek to describe the properties of finite and bulk nucleonic matter ranging from the deuteron to neutron stars and nuclear matter; including strange matter
- We want to be able to extrapolate to unknown regions

There is no “one size fits all” theory for nuclei, but all our theoretical approaches need to be linked. We are making great progress in this direction.

What is next?

- Feb. 2, Working group report due
- End of March, White paper complete
- End of April, Resolution meeting